Automated Digital Terrain Model Generation from HiRISE & LROC Imagery

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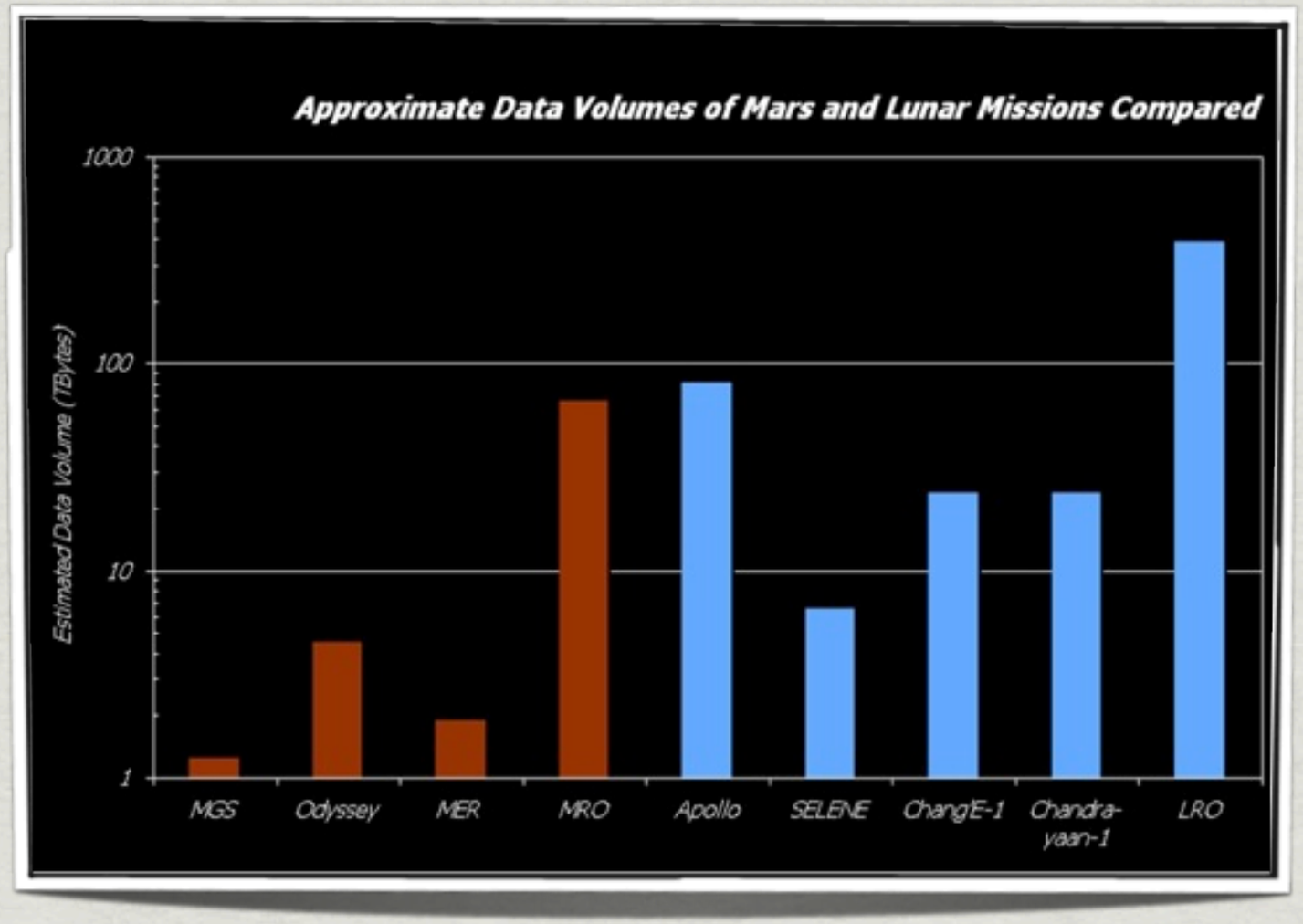
Preparing for the Flood of Mars & Lunar Data

- Data volumes from HiRISE & LROC are substantially larger than any previous mission.
- Human intensive processes need to be automated so that data can be processed efficiently.
- HiRISE at this moment has 1,353 available stereo pairs! Only tens of which have been processed.



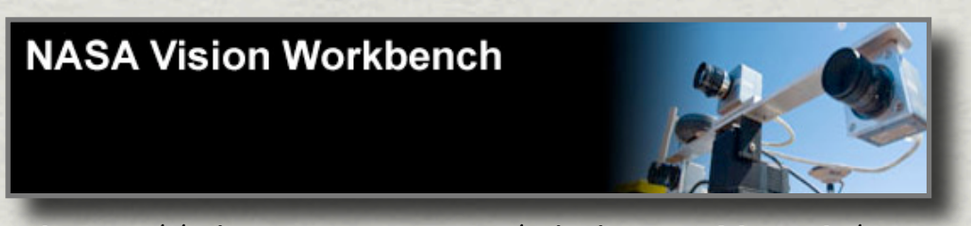
Source: B. A. Archinal, L. R. Gaddis, R. L. Kirk, T. M. Hare, and M. R. Rosiek. Urgent Processing and Geodetic Control of Lunar Data. Workshop on Science Associated with the Lunar Exploration Architecture, 2007.

What we Proposed to AISR

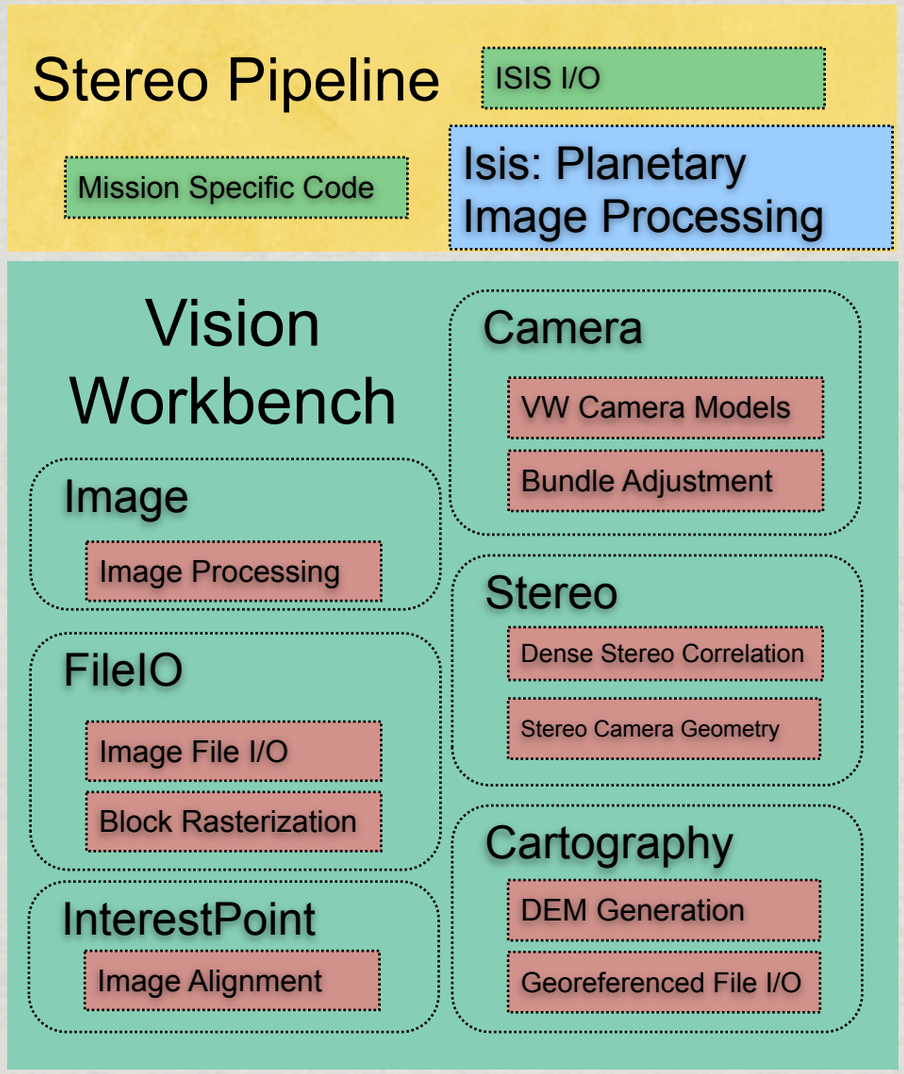
- Mature our own existing software, *Ames Stereo Pipeline*, for automated 3D terrain reconstruction
- Integrate USGS's Isis into our software for access mission specific camera information.
- Add support for very high resolution cameras (e.g. HiRISE and LROC)
- Provide detailed comparisons between DEMs produced by our software and alternatives.
- Give HiRISE and LROC mission support to ensure software meets demands.

The Ames Stereo Pipeline

- Provides foremost the ability of Stereo Processing (Image Correlation).
- Has Bundle Adjustment tools for alignment between images and large data products like ULCN.
- Finally provides Data Visualization in forms of 3D models, GeoTiffs, and Google Earth KMLs.

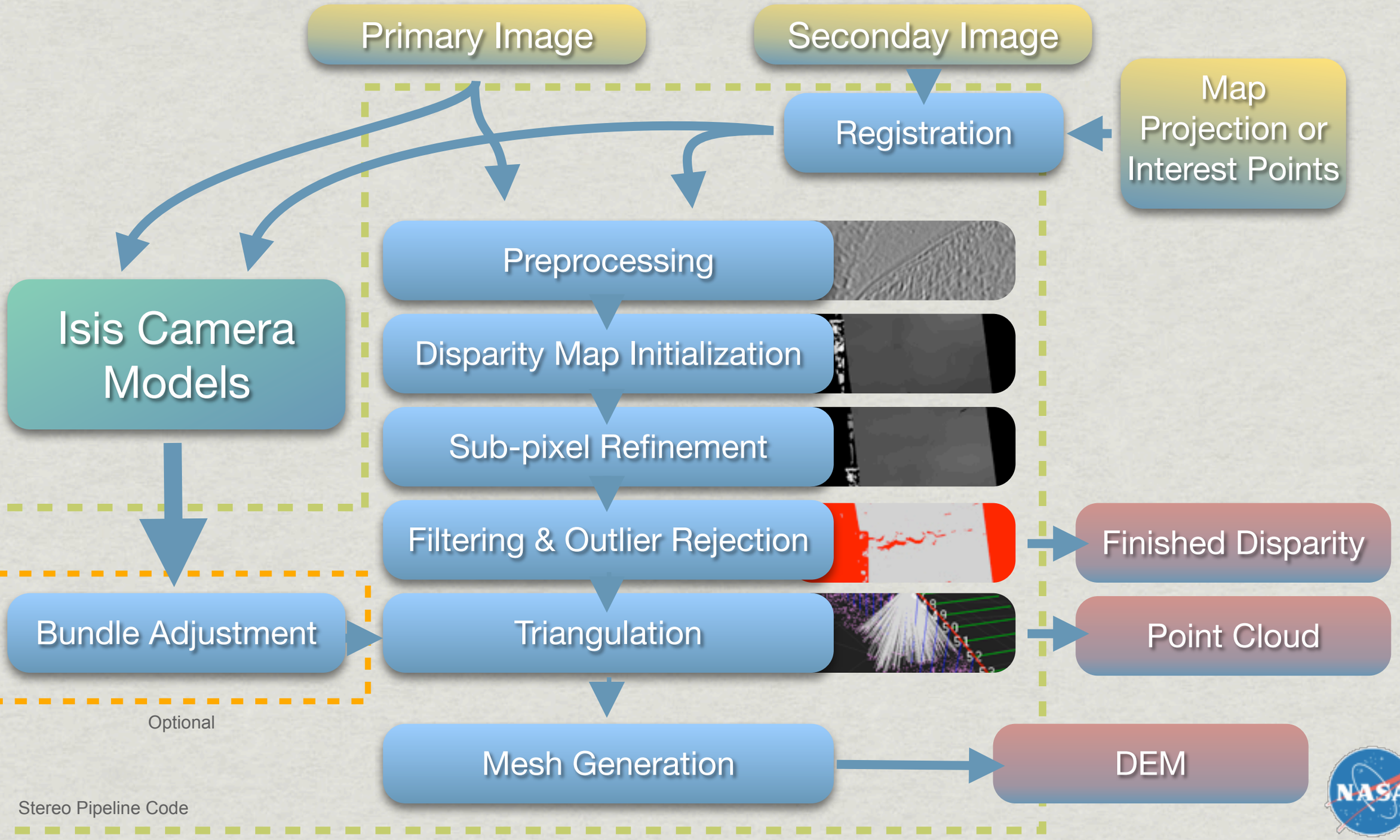


http://ti.arc.nasa.gov/visionworkbench/



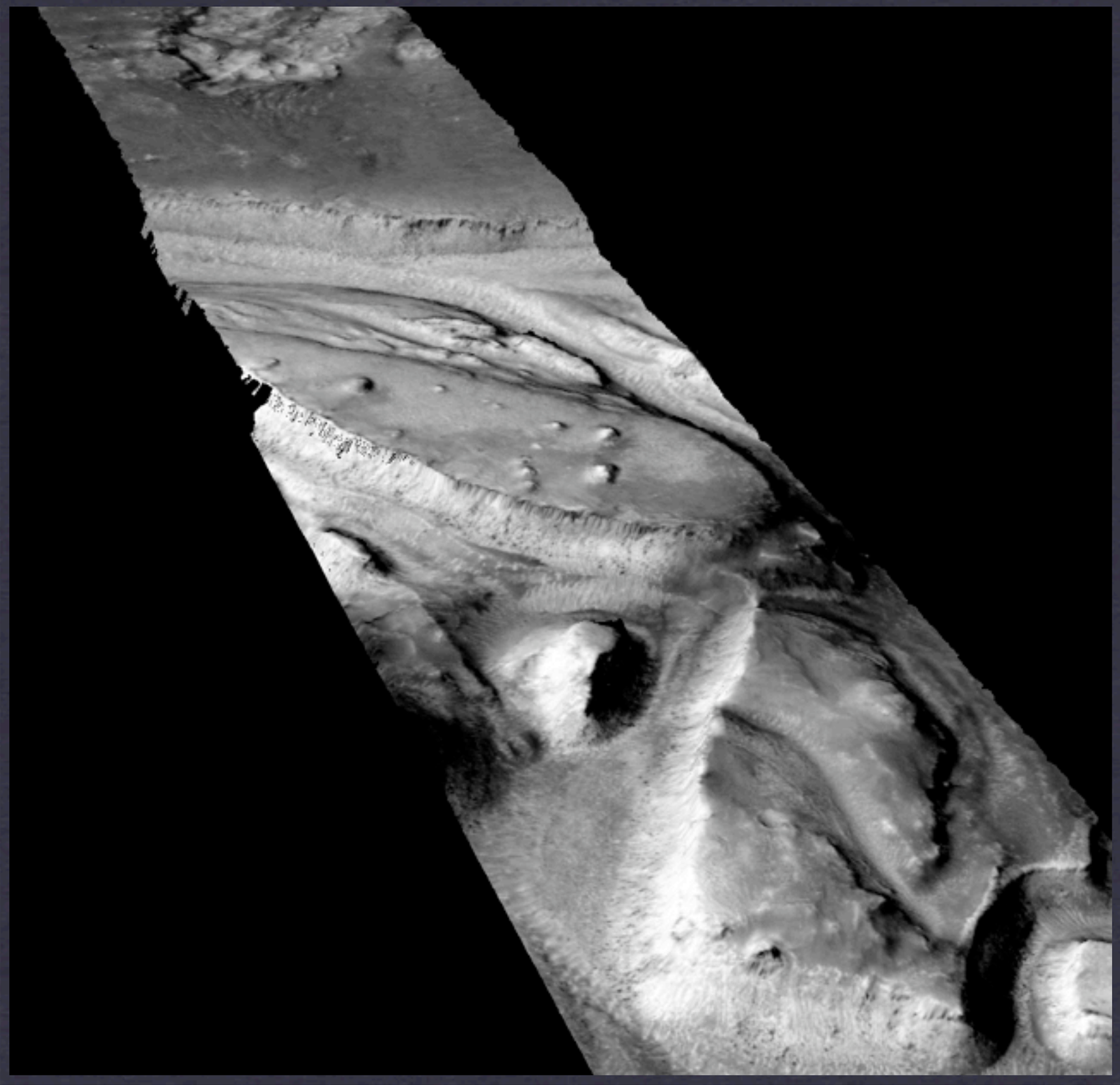
Stereo Pipeline is mostly just a collection of applications built on top of Vision Workbench and Isis.

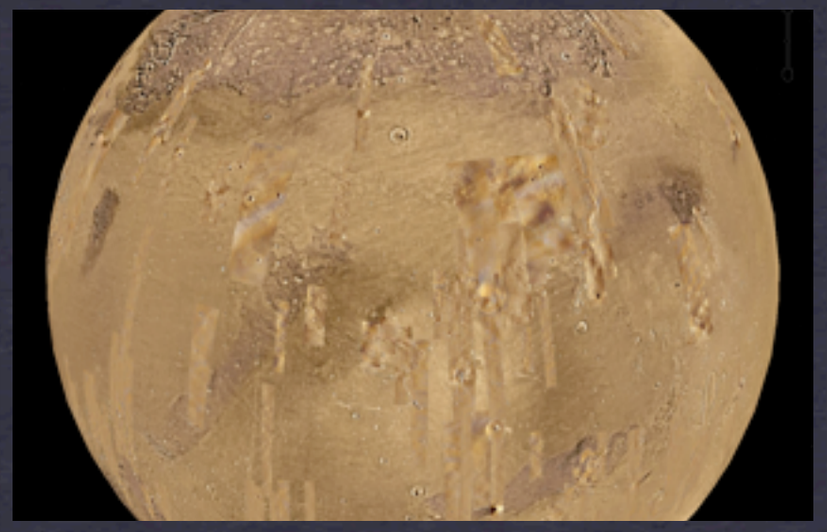
Stereo Pipeline's Process

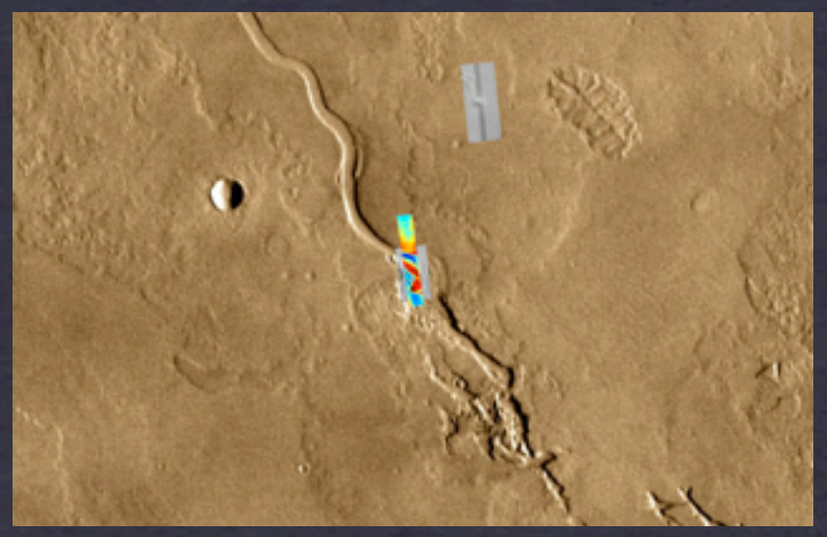


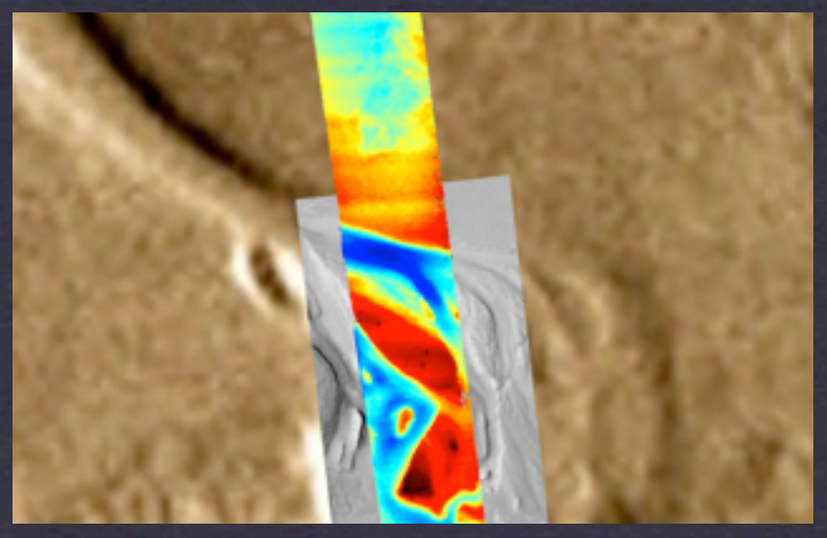
What's Been Happening this Last Year

- *Accomplished Goals*
  - Added the ability to create HiRISE terrain models.
  - Performed initial models with LROC.
  - Releasing alpha version software.
- *Added Features*
  - Affine sub-pixel refinement.
  - Camera Bundle Adjustment.
  - Large format image support.



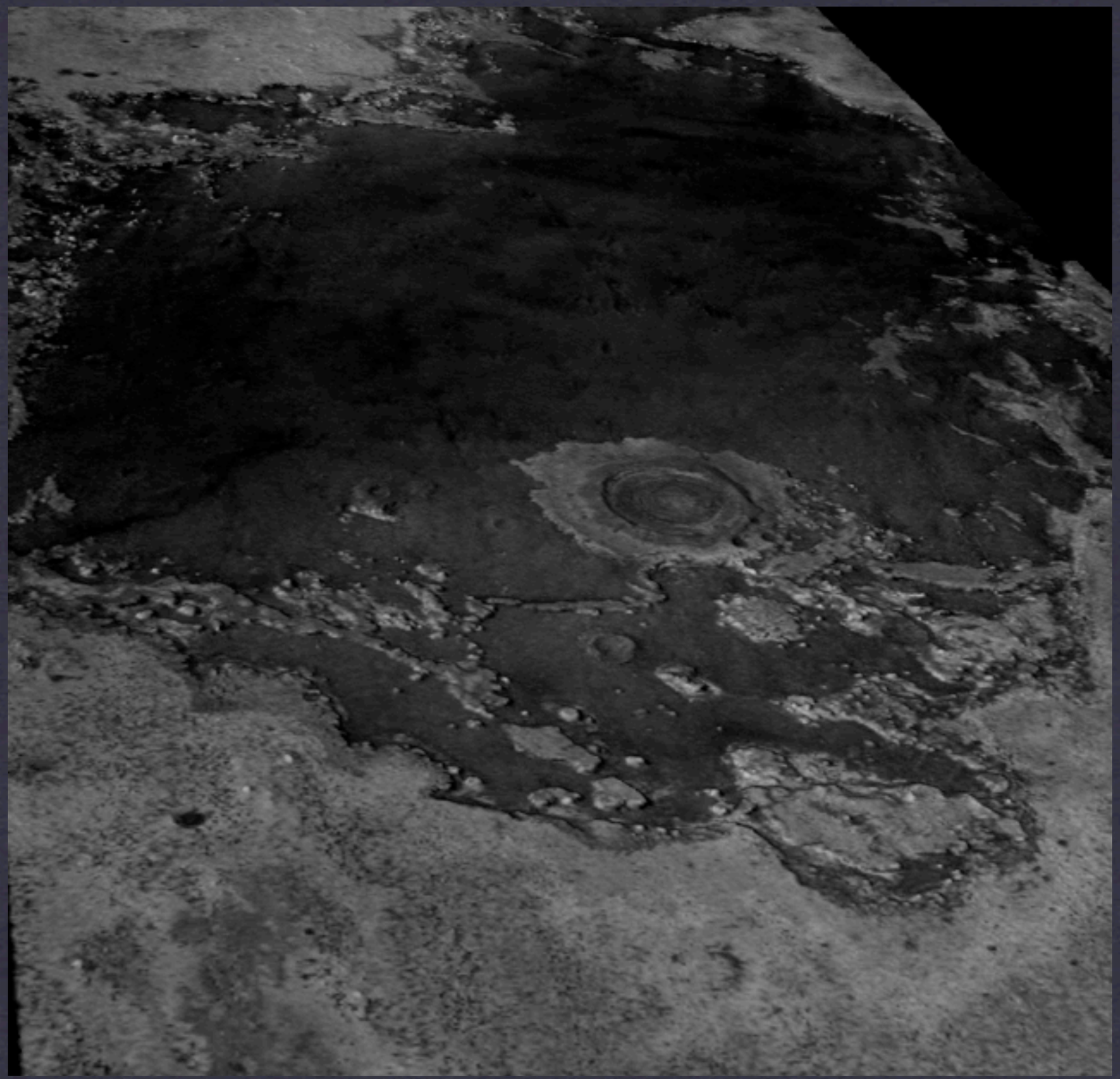


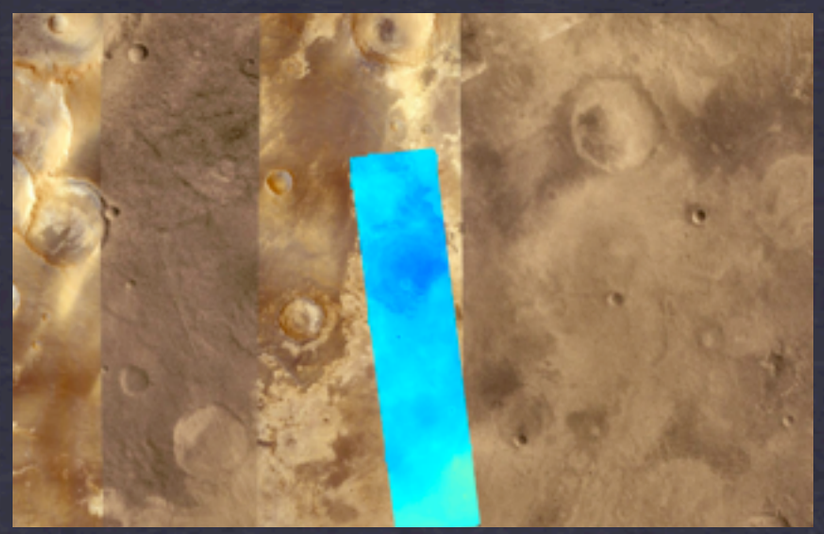


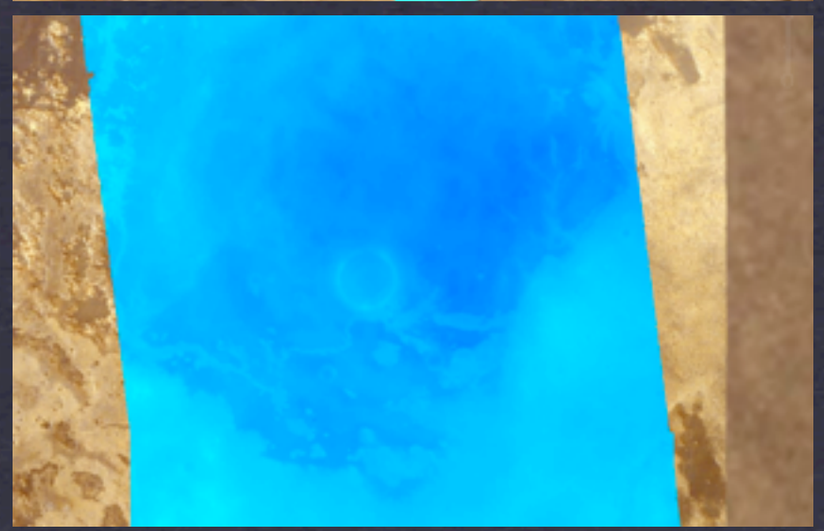


MOC-NA : “GALAXIUS FLUCTUS CHANNEL”

INPUT MAP PROJECTED IMAGE SIZE: 20 MB (672 BY 4,864 PX)

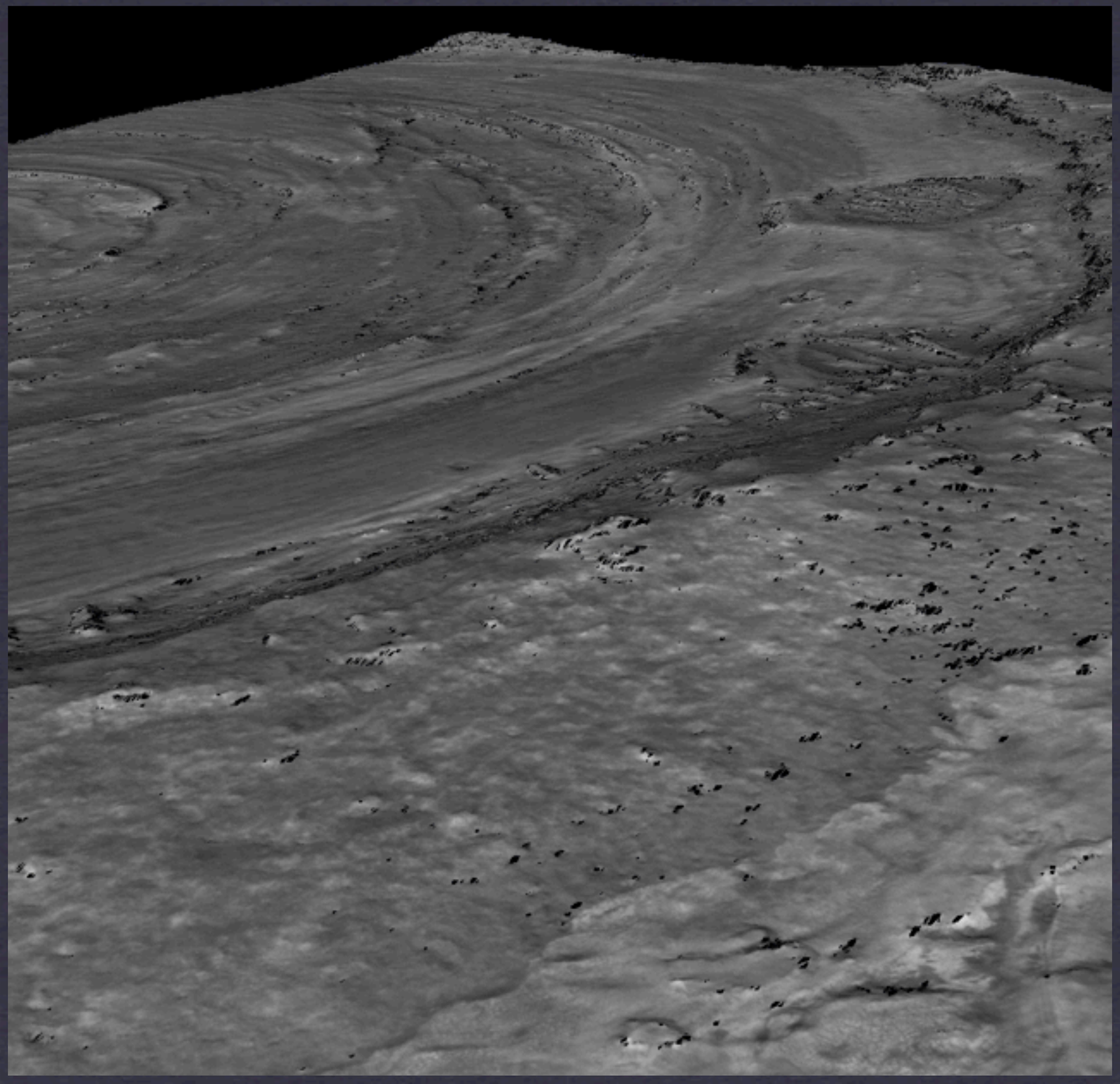


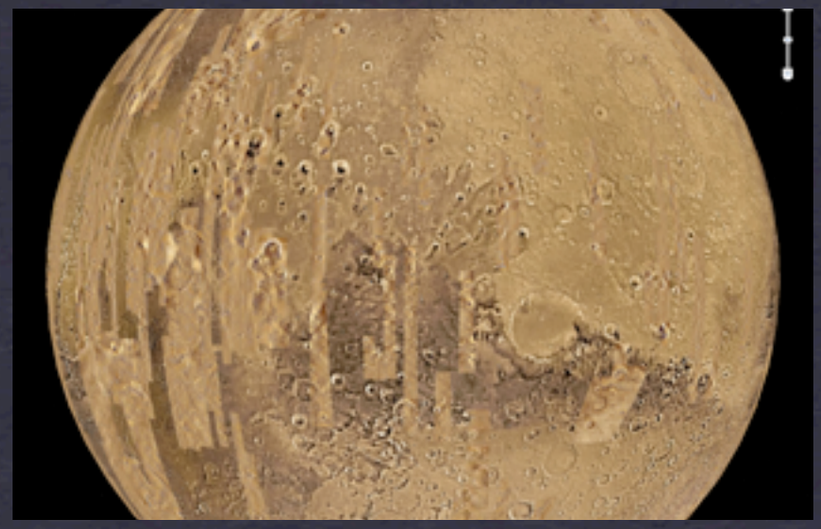


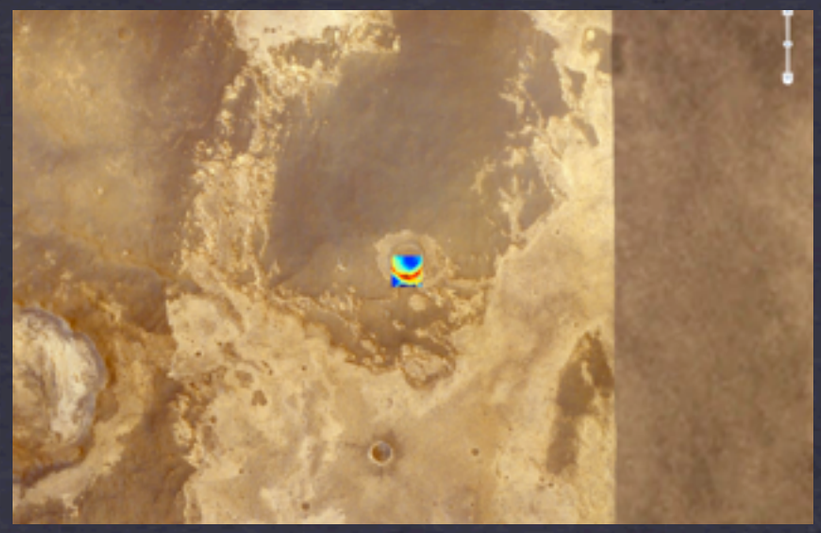


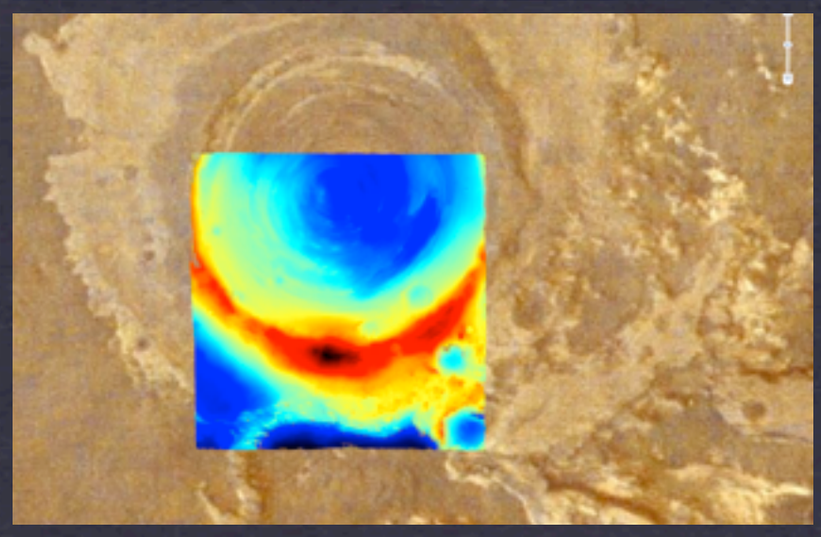
CTX : “NORTH TERRA MERIDIANI”

INPUT MAP PROJECTED IMAGE SIZE: 682 MB (8,110 BY 21,619 PX)



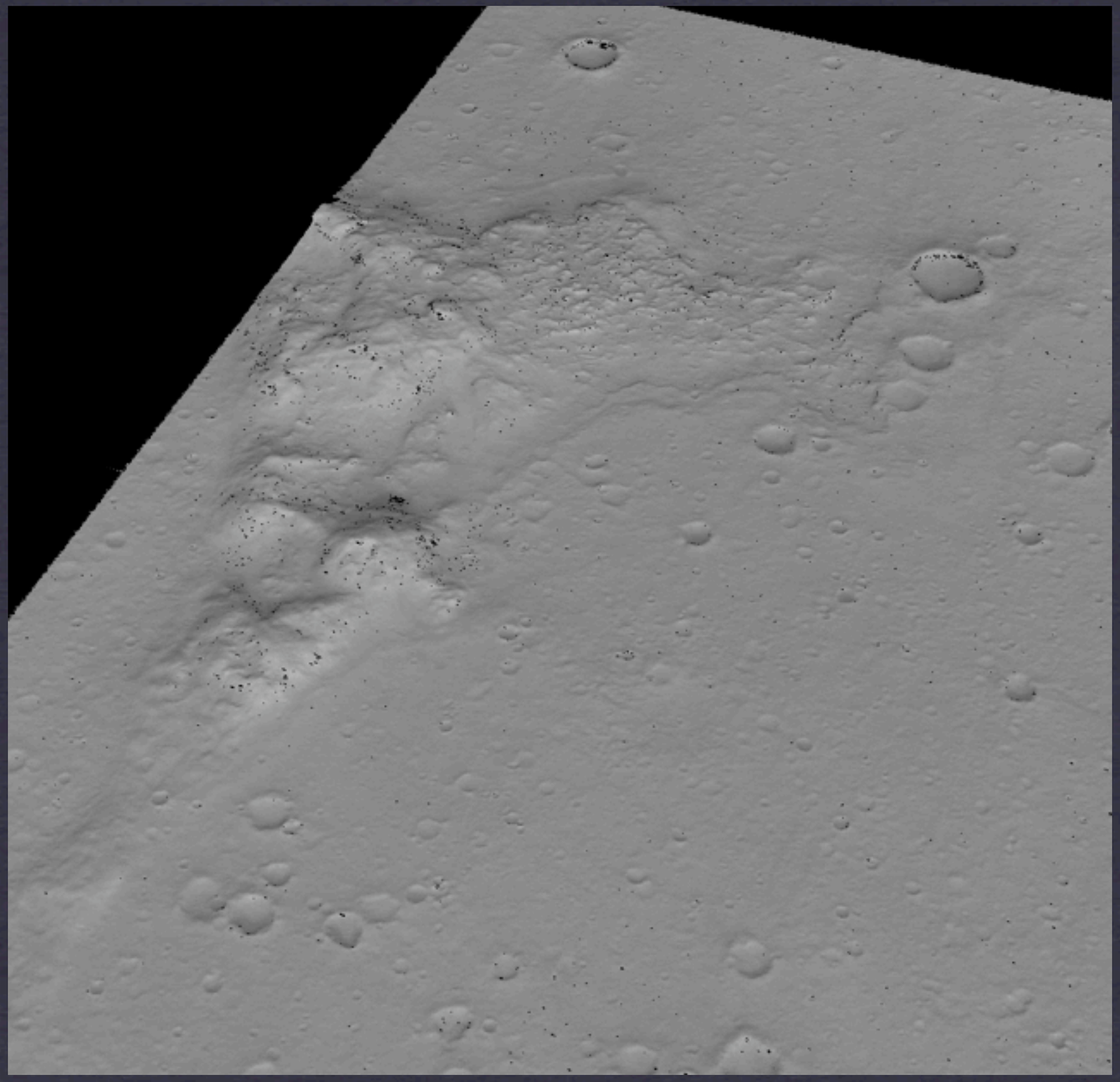


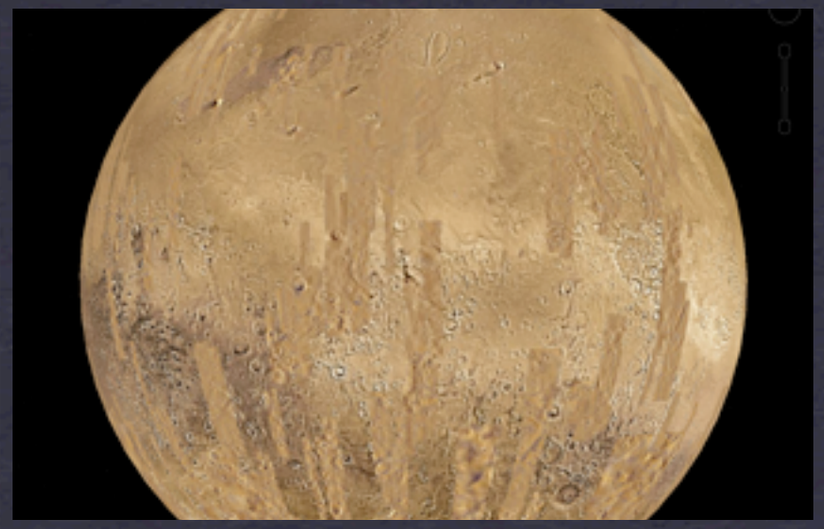


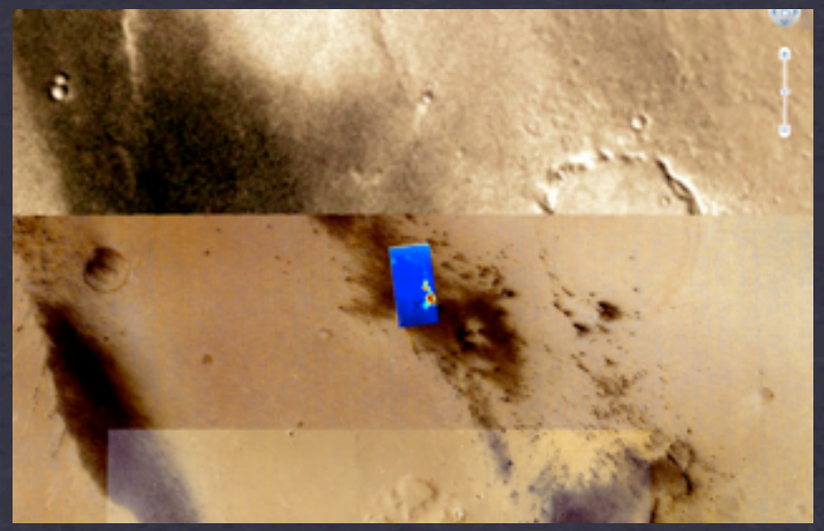


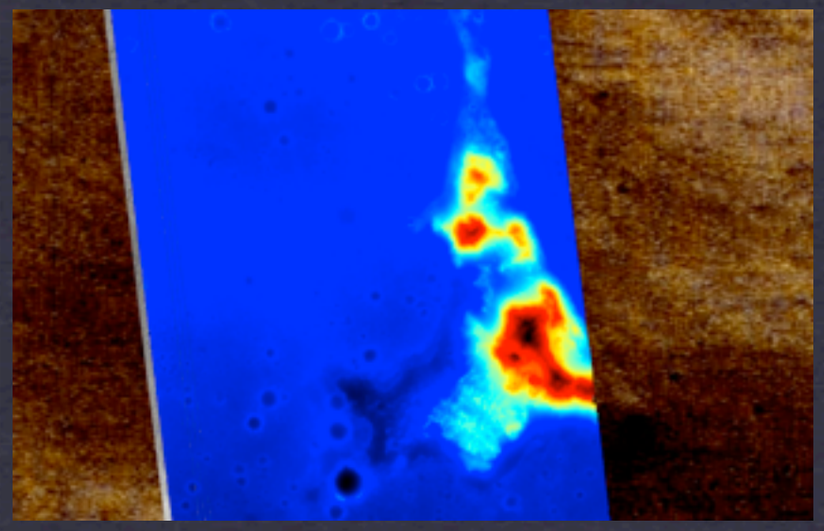
HIRISE : “NORTH TERRA MERIDIANI”

INPUT CROPPED MAP PROJECTED IMAGE SIZE: 409 MB (10,000 BY 10,000 PX)



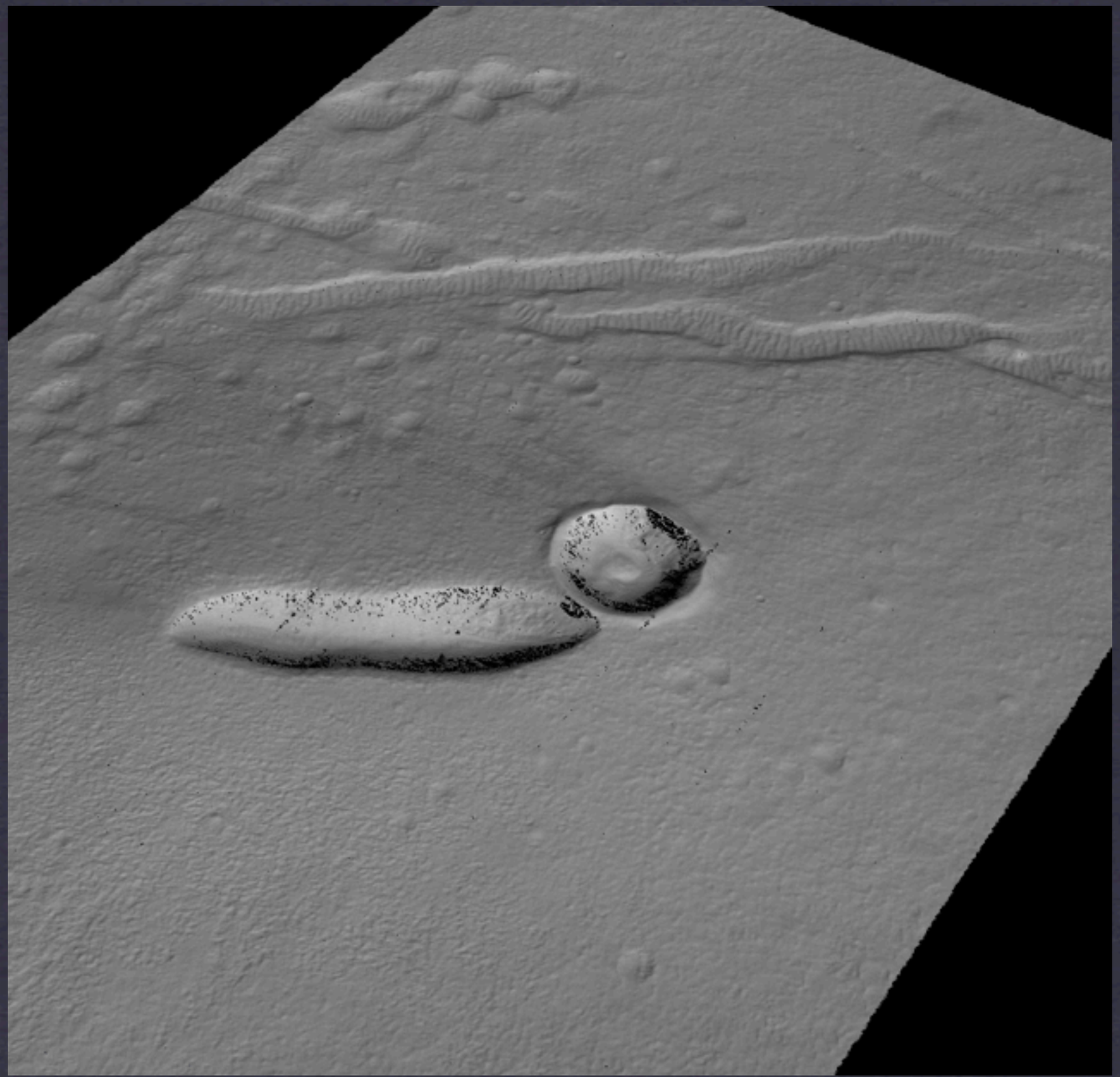


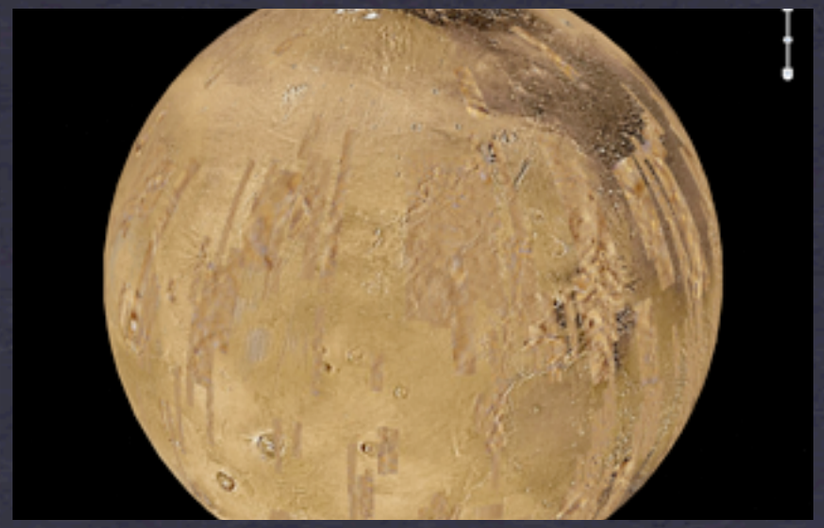


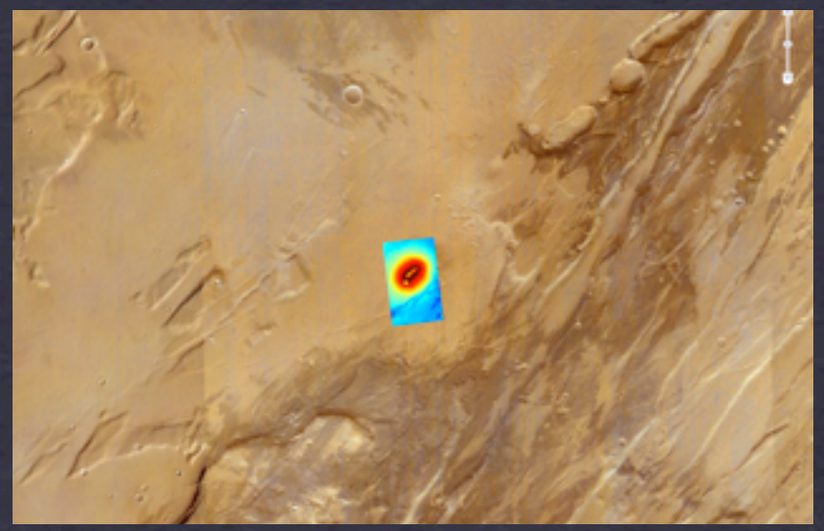


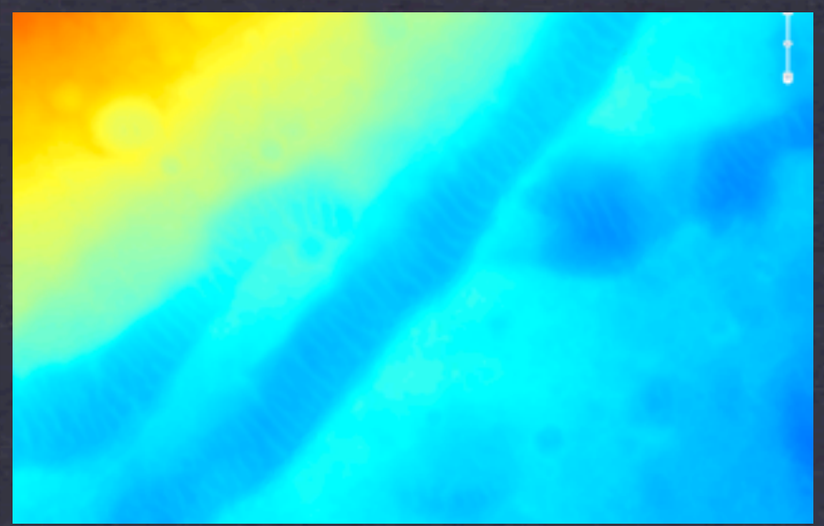
HIRISE : “COLUMBIA HILLS”

INPUT IMAGE SIZE: 3 GB (20,000 BY 40,000 PX)









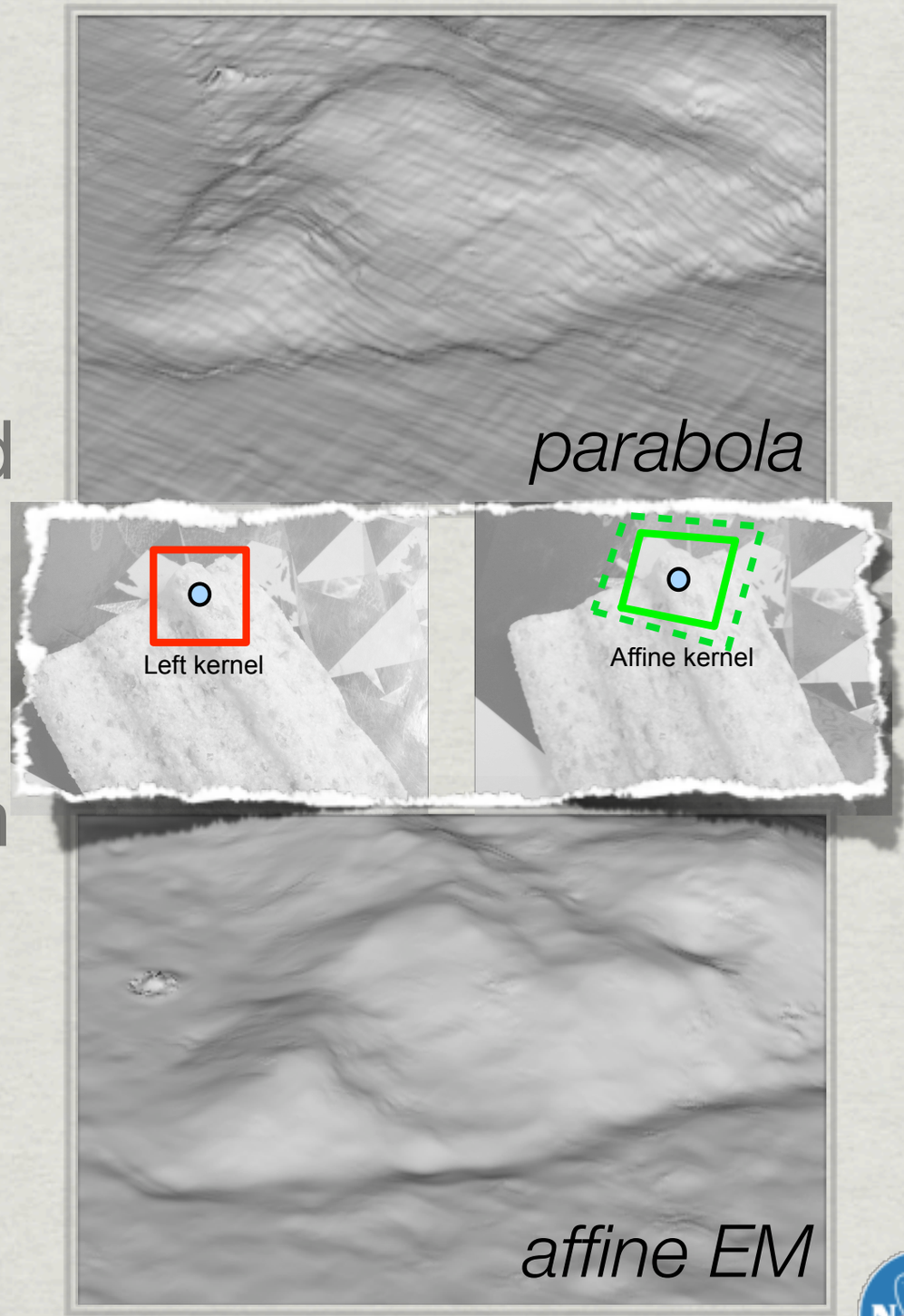
HIRISE : “EAST MAREOTIS THOLUS”

INPUT MAP PROJECTED IMAGE SIZE: 807 MB (11,896 BY 17,581 PX)

Improved Subpixel Refinement

- Stereo Pipeline now includes an alternative to parabola fitting that instead uses an affine template window.

- This new algorithm uses an Expectation-Maximization algorithm to be robust against noise.



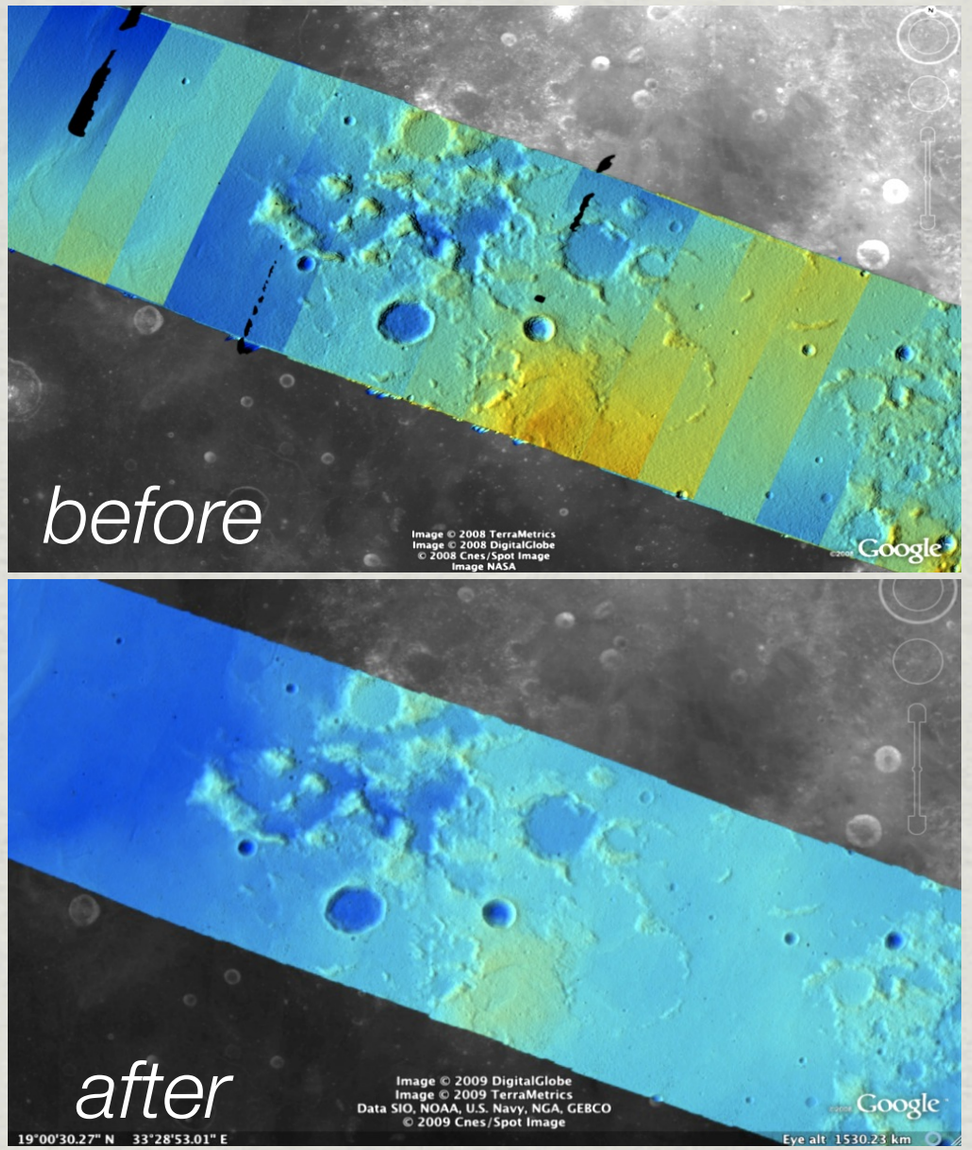
Data: Apollo 15 Metric Camera, Northern tip of Hadley Rille

Included Bundle Adjustment Utilities

- Stereo Pipeline also allows for the alignment of cameras with Bundle Adjustment.

- This can be performed between cameras so their DEMs align.

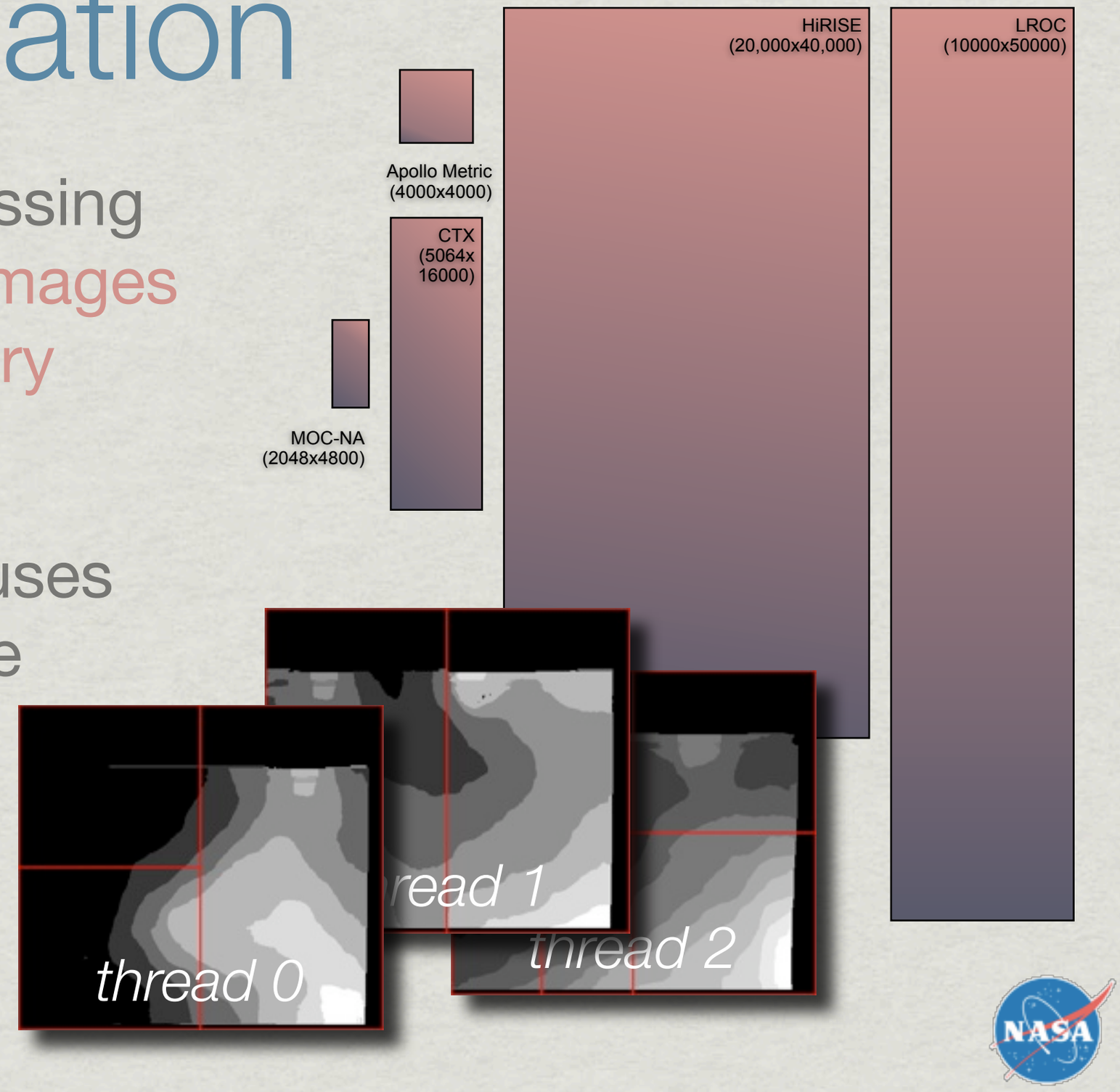
- Can also be applied with ground control points for alignment with global products like ULCN2005.



Data: Apollo 15 Metric Camera, rev 33

Implemented Tiled Rasterization

- Allows for processing arbitrarily large images with fixed memory usage.
- Stereo Pipeline uses multithreaded tile rasterization for complete CPU utilization



The Ames Stereo Pipeline

NASA's Open Source Automated Stereogrammetry Software

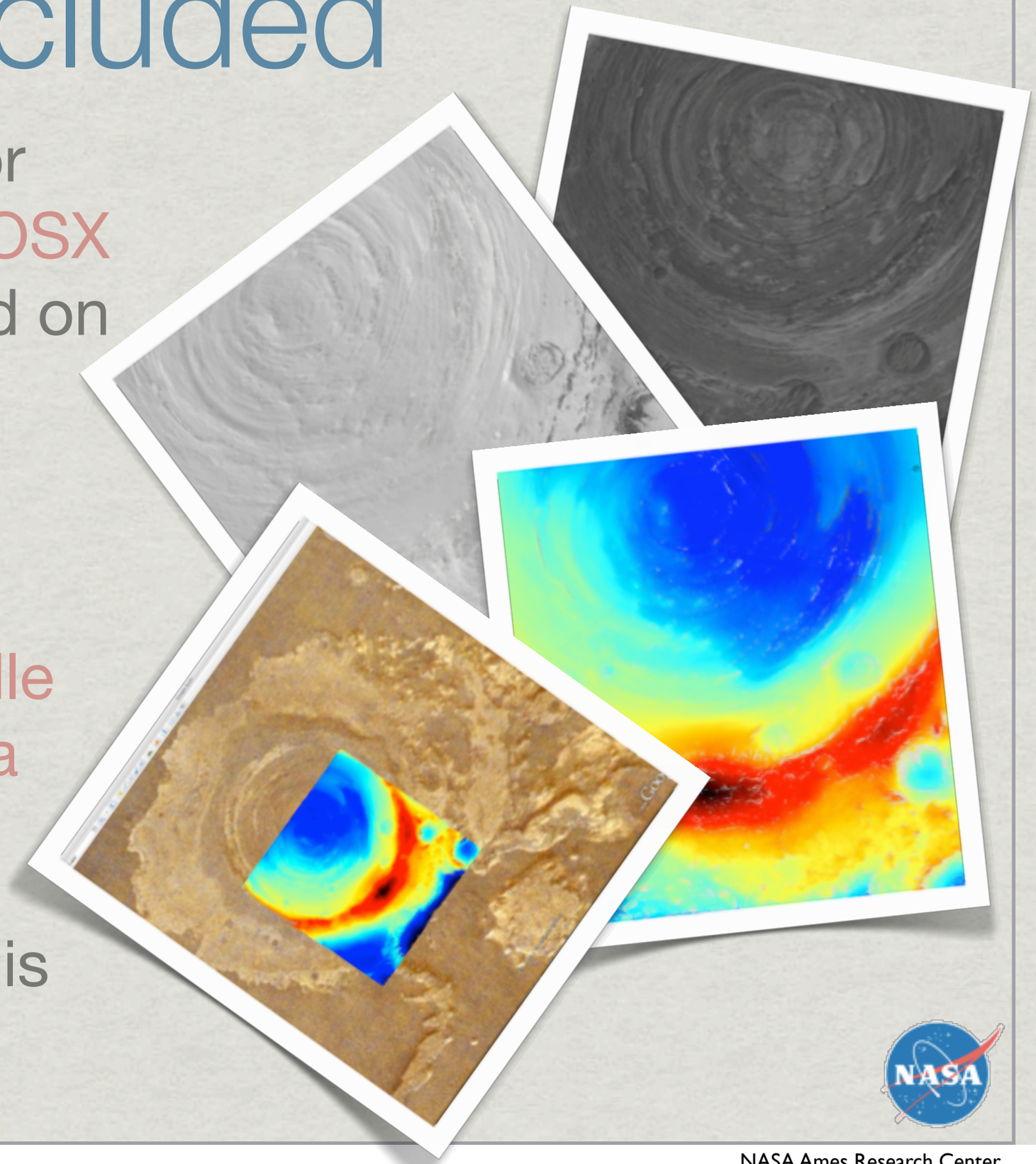
Version 1.0 Alpha

Available next Friday (Oct. 23rd)

http://ti.arc.nasa.gov/ngt/stereopipeline/

What's Included

- Binary distribution for Linux 32/64 bit and OSX 32 bit. This is applied on top of pre-existing installations of Isis.
- Tools for stereo reconstruction, bundle adjustment, and data visualization.
- Alternatively, source is available.



Target Audience

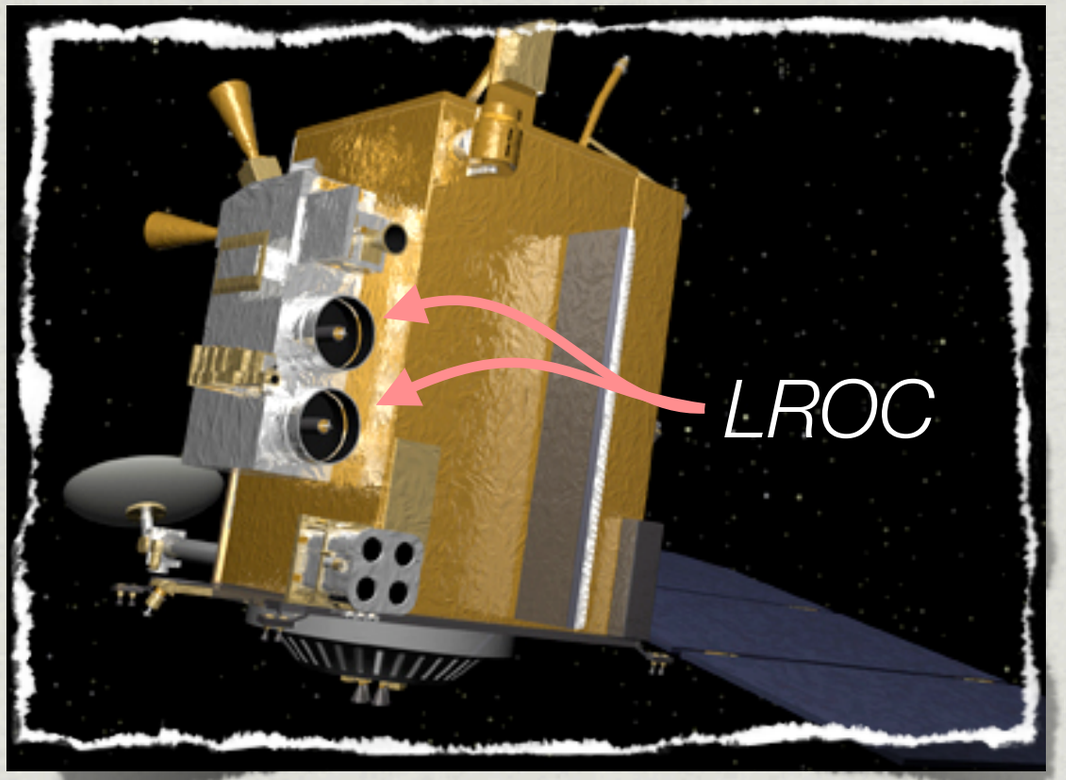
- Planetary Scientists, especially from USGS, ASU, U of A.
- This is an alpha release, and is a preview of what is to come.
- We want people to explore the software and to offer constructive criticism.

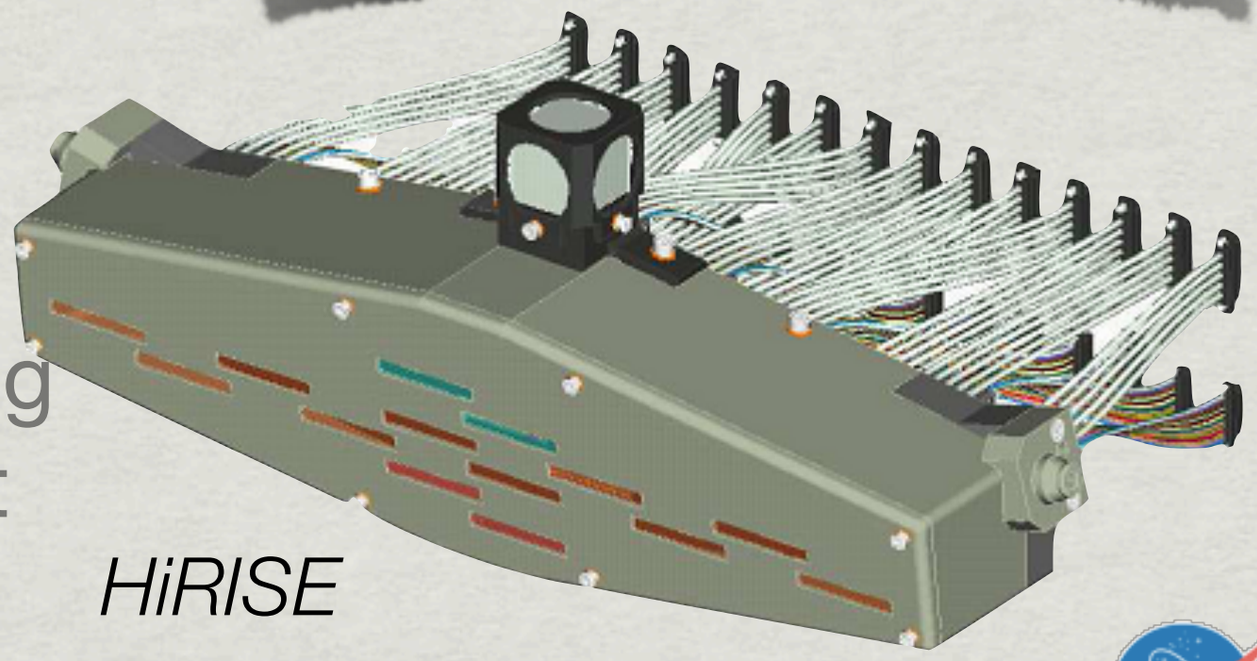
Summary of What was Achieved During Year 2

- Added the ability to process HiRISE images for terrain models.
- Initiated work to process LROC images.
- Provided tools to perform camera alignment with Bundle Adjustment.
- Releasing the Ames Stereo Pipeline to the public as Open Source.

Future Goals

- Improve support for multi-CCD cameras.
- Working with LROC and HiRISE team to incorporate our software into their pipeline.
- We will publish a peer reviewed report comparing our data products against USGS's DEMs.





HiRISE

Questions?

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http://ti.arc.nasa.gov/ngt/stereopipeline/